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AN APPROACH TO LONG-RANGE FORECASTING.(U)

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A RAND NOTE

Prepared For

AN APPROACH TO LONG-RANGE FORECASTING

J. E. Murray

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The Defense Intelligence Agency

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note

An introduction to-a method for making long-range (10-20 years) forecasts of Soviet strategic weapon developments. As the end product of a heuristic reasoning process, the methodology has a "requirements" orientation, based on clues from Soviet military writing, Soviet technology, and Soviet acquisition practices. Progressing through a sequence of four central inquiries, the methodology examines Soviet mission priorities, weapon deficiencies, and weapon options to forecast Soviet weapon choices. These four inquiries are supported by five background inquiries into Soviet military concepts, Soviet perceptions of threat, current Soviet weapon capabilities, Soviet advanced weapon technology, and available Soviet resources. After describing the overall methodology, this note discusses each of the nine inquiries and presents the author's viewpoint on their boundaries and emphasis. 23 pp.

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PREFACE

This Note describes a methodology for forecasting Soviet ballistic missile developments. This methodology was developed under a research program sponsored by the Weapons and Systems Division, Directorate for Scientific and Technical Intelligence, Defense Intelligence Agency. The objective of the research program was to determine Soviet ballistic missile developments likely to become operational in about 10 to 20 years.

In the interest of reaching a wider audience with an unclassified document, the author has stripped away all discussion of applications. The methodology is not an algorithm, or set of decision rules; applying the methodology, different teams of forecasters may well arrive at different forecasts. To date, some parts of the methodology have been tested in greater detail than others.

This Note may aid intelligence analysts and planners in assessing the future Soviet military threat.

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SUMMARY

Since its formative "crash" phase in the early 1960s, the Soviet ballistic missile program has expanded steadily with a concurrent increase in lethality. Today the program includes activities at four ICBM design bureaus, at test ranges, at several main assembly plants, at hundreds of component production plants, and at numerous launch complexes. Soviet acquisition procedures somewhat resemble the DoD DSARC management process--except for the following major differences: the Soviet system is more strongly committed to incremental progress, and major Soviet design bureaus are assured of continuing work.

This working note develops a heuristic method for forecasting technical developments in Soviet ballistic missiles, developments which might become operational in about ten to twenty years. Matters regarding future Soviet orders of battle and the relative suitability of alternative weapons are not addressed. The method combines data from Soviet doctrine, Soviet technology, and past Soviet practices with what is basically a "requirements" approach to forecasting. A requirements approach assumes that the Soviet leadership establishes the direction of the Soviet program according to national goals, and that a Soviet bureaucracy interprets these broad directives in light of its familiarity with (1) the technical demands posed by the perceived threat, and (2) Soviet systems, advanced technology, and resources. Adopting a Soviet orientation, the forecasting methodology specifies a sequence of interrelated investigations which distill and interpret the available information on Soviet ballistic missile activity.

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ACRONYMS

ASW	antisubmarine warfare
CONUS	continental United States
DSARC	Defense Systems Acquisition Review Council (U.S.)
EMP	electromagnetic pulse
ICBM	intercontinental ballistic missile
IOC	initial operational capability
MAD	mutual assured destruction
MRBM	medium-range ballistic missile
MTBF	mean time between failures
PATTERN	Planning Assistance Through Evaluation of Relevance Numbers
PERT	Program Evaluation and Review Technique
P_k	probability of kill
QUEST	Quantitative Utility Estimates for Science and Technology
R&D	research and development
RV	reentry vehicle
TEL	transporter-erector-launcher
TORQUE	Technology Or Research Quantitative Utility Evaluation
SLBM	submarine-launched ballistic missile
SRBM	short-range ballistic missile
SSBN	fleet ballistic missile submarine (nuclear powered)

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... all intelligence services essentially overestimate the rationality of the decision-making process which they are analyzing.

Henry Kissinger, speech at 1979 NATO Conference at Brussels.

I. CHOICE OF FORECASTING METHODOLOGY

This note explores the process of forecasting Soviet ballistic missile developments which may become operational in about 10 to 20 years. Since it is generally agreed that the Soviet weapon system design cycle requires approximately a decade from concept definition to initial operational capability, we intend that the method be used to forecast the generation of weapons following the one now in design.

We have some knowledge of Soviet weapon design and development practices--practices which are evident in essentially all Soviet families of weapon systems. Major acquisition decisions on Soviet ballistic missile programs are thought to require approval by the Politburo, an apparently cohesive, self-perpetuating oligarchy. The Politburo, it is claimed, is guided by the Soviet theory of a "correlation of forces," a continuous global net assessment of power (military, economic, and political) which is used to shape the most advantageous course for future Soviet action. The Politburo's involvement facilitates the initiation of crash programs to develop major new weapon systems, i.e. systems without any direct precedent. Examples of weapons developed under such programs are jet planes, nuclear and thermonuclear weapons, and ballistic missiles. Currently, a crash program to develop directed-energy weapons may be under way. At some point, responsibility for continued development passes from its temporary management structure to a set of permanent institutions. Thus ballistic missile developments became "institutionalized" by the mid-1960s. In institutionalized programs, weapons often achieve the performance

increments needed to accomplish their specialized missions by means of evolutionary improvements in established component designs. These weapon development practices are consistent with a highly conservative, centralized planning and management process which encourages the timely achievement of agreed-on objectives.

We also know something about Soviet procurement practices. The military R&D process is carried out at thousands of Soviet scientific centers. If a proposed ballistic missile system is approved, the work is turned over to a design bureau which specializes in ballistic missiles. Design bureaus can anticipate follow-ons to their existing programs and, in fact, have grown steadily for the past fifteen years. Although the formal Soviet implementation of their acquisition process resembles the U.S. DSARC process, the Soviet practice of prearranged follow-ons has avoided the problem of "feast or famine" which is endemic to the United States' system of weapons acquisition.¹

The Soviet management style offers both hope and pause to the forecaster of long-range developments in ballistic missile programs: On one hand, the Soviet management structure facilitates coherent long-range plans, which, hopefully, the forecaster can discern. On the other hand, the closed Soviet society masks disparities between theory and practice. Accordingly, the forecaster must not become wedded to one perspective. He must draw upon Soviet doctrine, Soviet technology, and past Soviet acquisition practices.

Which forecasting method best mixes the above ingredients is open to question. Two of the traditional forecasting techniques have serious deficiencies, especially for long-term projections: (1) *Extrapolation* both amplifies any distortions introduced by errors yet unrecognized in prior assessments of technology developments and fails to accommodate revolutionary advances in technology, and (2) *Mirror Imaging* overlooks important differences in Soviet military strategy, doctrine, technology, current force structure, and political/economic environment.

Other possible forecasting techniques also have drawbacks. Conceptually, computer-based R&D planning models could be adapted to project Soviet strategic missile developments. In general, these planning models (e.g., TORQUE, RDE, PATTERN, and QUEST) define a set of objectives

and then score candidate projects on the basis of a weighting scheme which is additive over the multiple objectives. To the best of our knowledge, none of these models has sufficiently justified its continued use in military R&D planning. Some causes of the models' limitations are readily discernible: (1) Although the models require numerical weights, the individual importance of the military forces' multiple missions (objectives) cannot be scored satisfactorily; (2) By assuming that the improvement caused by incremental changes in two technologies is equal to the sum of the technologies' individual marginal utilities, the additive weighting schemes ignore the often important synergism among technologies (e.g., accuracy and yield); and (3) Preparing input for the models is time-consuming and, inevitably, requires that the analysts supplement the data with their own judgments. In the final analysis, the utility of these computer-based models is determined by their ability to model factors thought important by the particular user.

The intuitive techniques such as Delphi also have disadvantages. In the Delphi technique, a panel of specialists develops a consensus by responding to several rounds of increasingly specific questions. One critic characterized the technique's vulnerability as follows: "I would prefer the opinion of one expert to the opinion of several, diluted by a multitude of incompetent guessers."²

A heuristic, Soviet-oriented approach, which proposes to perceive future Soviet strategic missile requirements (hence the methodology's name Perceived Needs), has proven more satisfactory than the above methods. Two sources have contributed to shaping this methodology. The first, Congressional testimony, advocated a requirements approach in USAF planning:

The Air Force Research, Development, Test and Evaluation (RDT&E) budget for FY 79 was the first major Air Force use of a three-step mission area planning process. This process began with mission area analysis to define and identify the deficiencies in our capabilities, proceeded through development planning to define alternative solutions, and concluded with zero-base budgeting actions to select affordable solutions that constitute an investment strategy.³

However, the second, a Rand study of the bureaucratic and budgetary constraints in forecasting Soviet force structure, restated objections to the requirements approaches, objections raised in the 1960s by Joe Loftus, Andy Marshall, and Tom Wolfe.⁴ These authors faulted requirements approaches because such approaches:

- o Seldom imply a unique procurement program.
- o Fail to account for constraints on Soviet planners.
- o Reinforce the myth of the monolithic Soviet decisionmaker.
- o Discount current Soviet practices.
- o Discount the leverage of Soviet R&D.

Having taken into account complications inherent in the Soviet system and various forecasting methods, we assembled the forecasting methodology as follows: Common sense dictated the choice of a Soviet orientation; the Soviet leadership's ability to act cohesively suggested its "requirements" framework; the USAF planning process provided a model for its organization; and previous criticisms of requirements methods modified its details.

The methodology is pictured in Fig. 1. Each of the nine facets shown represents an area of inquiry. Five areas, providing a data base for the forecast, are discussed in Sec. II. Four areas, which both organize and interpret the data and thus form the forecast itself, are discussed in Sec. III. The relationship between the nine areas of inquiry is more easily understood when the figure is viewed as a PERT chart ending in a prediction of what new weapon systems the Soviets may deploy during the period of interest. Reading from right to left (see Fig. 1): the Soviets' *weapon options* will depend on the *resources* available and on the *available resources* (including economic factors, scarce test and production facilities, and specialized military support). The weapon system options will, in turn, likely be affected by the *weapon deficiencies* which the Soviets perceive in their current systems and the *technology advances* which they can incorporate in time to be useful. Soviet weapon systems' deficiencies will likely be evaluated in terms of both the *priorities* the Soviets assign within their

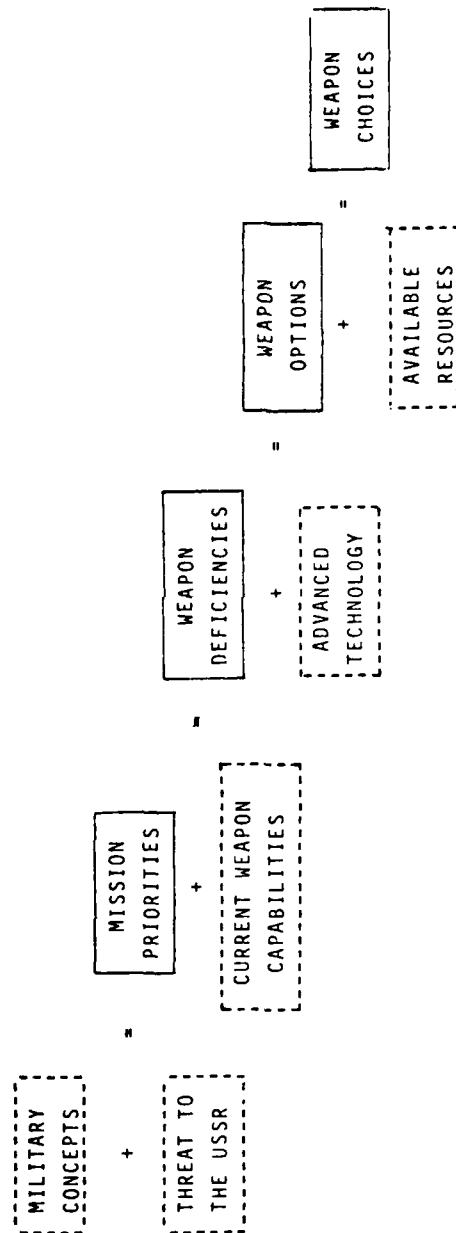


Fig. 1--Forecasting methodology--nine areas of inquiry

NOTE: Five areas of inquiry (see boxes with broken lines) form the foundation of the forecast.
 Four areas of inquiry (see boxes with solid lines) form the actual forecast.

broad range of military missions and the *capabilities* of their current weapon systems. And finally, the Soviets' priorities must be deduced from their avowed *military concepts* and from their own perception of the *threat* (from the United States, NATO, PRC, etc.)

Our forecasting method offers two internal means for checking its consistency. First, if military requirements do dominate the Soviet acquisition process, then the forecaster may logically expect that Soviet R&D will answer mission deficiencies with the required technological advances. If this R&D support is not detected, the forecaster must either examine his data for errors or conclude that Soviet military R&D is shaped less by military necessity than by technological opportunity.⁵ Second, the forecaster may expect Soviet weapon choices to conform to available resources. If the forecast choices are beyond the available resources, then the forecaster should retrace his steps. If, on the contrary, the resources exceed the requirements, then the forecaster may choose either to reexamine the data or conclude that the resources have developed their own unchecked bureaucratic growth pattern.

Certain caveats may be in order: As yet, I have not resolved the conflict between my impulse to choose either a quantitative or a qualitative approach. For example, one might ask whether "mission priorities" should be quantified into "operational requirements" before progressing to "weapon deficiencies." The "pro" argument is persuasive: One must quantify in order to know exactly what is being considered. The "con" argument is also impressive: One does not know the detailed calculations which the Soviets might use to refine ordinal rankings of their mission priorities. Furthermore, the reliability of the utility of such calculations (either theirs or ours) as indicators of future technological achievements is doubtful. In this heuristic approach, I tilt toward the "con" (qualitative) position.⁶

Finally, this methodology does not preclude the need for considering the future international situation. The forecast cannot be insensitive to such questions as: Will the Soviet government remain stable? Will there be a world economic depression? Will a nuclear weapon be launched accidentally? Will a nuclear exchange occur between Nth

countries? What course will SALT negotiations take? Will there be breakthroughs in the technologies of alternative (competing) weapon systems? Nevertheless, such issues should be evaluated outside the forecasting process. Interjecting such issues directly into the forecasting process tempts the forecaster to hedge his prediction by submitting multiple outcomes, thereby obscuring what might otherwise be a coherent review of information pertinent to a Soviet weapon program.

II. FOUNDATIONS OF THE FORECAST

Five areas of inquiry form the foundation of the forecast: military concepts, threat to the USSR, current weapon capabilities, advanced technology, and available resources. (See broken-lined boxes in Fig. 1.)

MILITARY CONCEPTS

The military concepts advanced in the Soviet "open" literature should be the departure point for forecasts of long-range Soviet weapon developments. Soviet protocol demands that this voluminous literature have the approval of the Soviet leaders. Since Khrushchev's retirement, Soviet leaders have given no evidence of the anguish expressed by their U.S. counterparts when deciding long-term "guns-vs-butter" policy matters. Soviet leaders are not troubled by the prospect of a large, well-equipped standing army. Their emphasis upon the projection of power in peacetime and the control of escalation in wartime (by seizing the offensive while retaining secure retaliatory capability) can be traced to their national resolve to defend the motherland and project socialism.

B. S. Lambeth⁷ has identified key themes in Soviet military doctrine:

- o The best deterrent is an effective war-fighting capability.
- o Victory is possible.
- o It pays to strike first.
- o Restraint is foolhardy.
- o Numbers matter.

None of these themes is new; in fact, each is recognizable in pre-revolutionary Soviet military literature. The forecaster must judge whether these same themes will continue to guide the Soviet leaders and bureaucracy toward a war-fighting military posture.

THREAT TO THE USSR

The Soviet long-term view of the threat posed by U.S., NATO, and PRC strategy must be considered. French strategy depends upon a

retaliatory, (i.e., second-strike) strategic force. This force utilizes mobile basing modes--primarily submarines and airborne alert aircraft--to achieve the requisite level of survivability. The British strategy is, and most probably will remain, similar.⁸ The PRC strategy is not known, but the limited size of its nuclear strike force suggests that it must rely on the threat of retaliation to deter Soviet nuclear aggression. More ambitious war-fighting strategies appear, at least for the foreseeable future, to be beyond British, French, and PRC capabilities.

The Soviet Union must be aware of the asymmetries between its strategic concepts and those of England, France, and the PRC. However, at least in the available open literature, the Soviet Union does not appear to recognize U.S. strategic differences. Claiming to see U.S. concepts similar to his own, Sokolovskiy declared that "American theoreticians are frankly in favor of preventive war and surprise attack. Public officials . . . in effect fully share these views."⁹ Sokolovskiy attached great significance to the "counterforce" tone of Secretary of Defense Robert McNamara's speech at the University of Michigan on June 16, 1962, and to the "guaranteed destruction" and "damage limiting" concepts put forth in McNamara's March 1965 testimony to the Armed Services Committee of the House of Representatives. Sokolovskiy overlooked the basic change in U.S. policy from the ever larger force structures required for war-fighting toward finite force structures which suffice for an assured destruction capability. Since 1965, the United States' erratic pace of strategic weapon acquisition, its fettered (by treaty) commitment to active defense (ABM), and its waning interest in civil defense have given further evidence of the United States' apparent disinterest in a war-fighting posture. Nonetheless, the recent rekindling of national interest in strategic forces may be seen by the Soviets as fresh evidence of the correctness of Sokolovskiy's "war-fighting" interpretation of U.S. concepts. The strong U.S. preference for mobile basing options for new ICBMs, the deployment of the Trident weapon system, and the introduction of precision guidance techniques on Pershing II and cruise missiles could be interpreted as parts of a U.S. pattern aiming toward high P_k , low collateral damage, highly survivable, rapidly deployable, and covertly stockpilable, weapons--weapons admirably suited to war-fighting.

CURRENT WEAPON CAPABILITIES

The performance improvements which distinguish current Soviet weapons from earlier designs are important indications of both the objectives of their designs and the progression of their technology. Among the best indicators of a missile's military purpose are its maximum range, throw weight, and accuracy. Since the designer has the freedom to trade off target coverage for payload, the final choice of maximum range is especially revealing: The maximum range of a Soviet ICBM determines whether it has full CONUS coverage (indicating a threat to the full spectrum of military and economic recovery targets) or more limited coverage (indicating a regional threat to ICBM forces and other targets in the northwestern sector of the United States). The maximum range of an SLBM governs its ability to evade U.S. ASW forces while maintaining coverage of CONUS targets. The maximum range of an SRBM determines the command levels in the Soviet Ground Forces to which the missile may be assigned.

The weight and accuracy of an RV further indicate the types of missions for which it is intended. For nuclear warheads, the weight is a good estimator of yield. From estimates of yield and accuracy, probabilities of kill can be readily calculated for plausible candidate targets. For non-nuclear payloads, the inquiry is more complicated, requiring, in addition, estimations of both the damage/kill mechanisms and the affected areas.¹⁰

In addition to evaluating the lethality of current Soviet weapons, the forecaster should weigh Soviet progress in improving command systems and reducing vulnerability (both prelaunch and in-flight). The Soviet concept of surprise seems to require a command system which can attain and maintain a high degree of readiness under positive control. However, some analysts claim that the Soviet forces have seldom demonstrated such a capability. The forecaster might well pay particular attention to this subject. In three areas especially, he may detect Soviet attempts to minimize missile vulnerability:

- o The incorporation of mechanical and/or electronic counter-measures to reduce in-flight vulnerability.

- o The introduction of design improvements which increase (a) the structural hardness of fixed silos, (b) the rattlespace within such silos, (c) the tolerance of the launch system to debris present in the silo, and/or (d) the MTBF for the missile while it is enduring in the silo in a no maintenance, post-strike environment.
- o The improvement in the emissions control and endurance of all mobile transporter-erector-launchers (TELs) including SSBNs, and the reduction in the amount of time required to prepare TELs for deployment.

ADVANCED TECHNOLOGY

Information about applied research/advanced development programs which the Soviets expect to result in future weapon systems developments would be especially helpful. However, since much Soviet basic analytic and laboratory work can be concealed, and highly visible experimental work can often be controlled and disguised or delayed when necessary, the forecaster may be compelled to investigate such indirect approaches as:

- o Scrutinizing other missile systems, mods, and variants (e.g., the SS-NX-13 and SS-X-16) to identify successfully demonstrated technologies which are, therefore, available for reintroduction or further improvement.
- o Considering other weapon systems with similar missions in order to identify subsystems, components, and techniques which may be adapted to ballistic missiles.
- o Looking for changes in Soviet test facilities and ranges which might presage new technologies.
- o Examining the open Soviet literature--both doctrinal and scientific.¹¹

AVAILABLE RESOURCES

Since the Soviet ballistic missile program became institutionalized about fifteen years ago, its resource allocations have increased at a stable pace--a pace which is apparently adequate to satisfy the demand of this ambitious effort. The availability of resources may be jeopardized should any of the following four scenarios occur:

- o Military programs lose priority over domestic programs.
- o The ballistic missiles program loses priority over other military programs.
- o The Soviet GNP falls precipitously.
- o The demand placed by ballistic missiles on the available resources surges.

The likelihood that these four scenarios may occur appears small due to the following considerations: During the past 30 years, the Soviets have invested considerable national prestige and economic and human resources in building a substantial ballistic missile program. They have organized an elite branch of armed forces around these new weapons. The program has doctrinal underpinnings: According to Sokolovskiy, "Rockets are the most effective and most promising means of armed combat."¹² In addition, since Soviet bureaucracy is conservative, secretive, and compartmentalized, its management style is not suited to the sort of unfettered technical debate which might break its entrenched attachment to ballistic missiles.

Admittedly, the Soviets may find that several problems impede their ability to expand the resources allocated to ballistic missiles. For example, the number of European Russians entering the work force is declining; a Soviet "energy crisis" may be approaching; and the Soviet Gross National Product growth rate is slowing. Such problems may even lead to an increase in the interval between successive generations of ballistic missiles. A "stretching out" of their program could conceivably delay the appearance of the fifth and sixth generation ICBMs beyond their nominal due dates of approximately 1982 and 1992. Even so, such stretching out could not be expected to postpone

the appearance of a sixth generation beyond the range of a twenty-year forecast.

Soviet missile production rates will no doubt fluctuate in the future as they have in the past. Changes in production schedules may occur as shifts in basing modes alter weapon system acquisition and life cycle costs.¹³

The investigator must initially determine the boundaries of his inquiry into Soviet resources. He should focus on those areas where his forecast may disagree with prevailing assessments of Soviet capabilities. He should be especially wary of ambitious excursions into Soviet economic prospects. Such excursions are unlikely to be accurate enough either to validate or contradict an otherwise plausible forecast.

III. FORMATION OF THE FORECAST

Four areas of inquiry, discussed below, form the forecast: mission priorities, weapon options, and weapon choices (see solid boxes in Fig. 1).

MISSION PRIORITIES

As discussed in Sec. II, two inquiries provide the essential background for investigating mission priorities: *Soviet military concepts* and Soviet perceptions of the military concepts of their potential enemies, i.e., *threat to USSR*. That the Soviets embrace a war-fighting posture appears evident both from their doctrinal literature and from their weapons procurement. As noted above, some Soviets profess to discern a similar rationale behind the U.S. posture. Therefore, it seems reasonable to anticipate that, given the bureaucracy of the USSR's central leadership, the Soviets will continue along their current path, claiming justification of their behavior in an alleged U.S. "war-fighting" posture.¹⁴

Soviet doctrinal literature clearly states the primary importance of ballistic missiles. Regarding the ICBMs and MRBMs of the Strategic Rocket Forces, Marshal Grechko states:

The Strategic Missile Forces, which form the basis of the combat might of our Armed Forces, are intended for the destruction of the enemy's means of nuclear attack, his large troop formations and military bases, the destruction of the aggressor's defense industry, the disorganization of his state and military command and control and of the operations of his rear and transportation.¹⁵

The role of SLBMs is portrayed similarly, with one possibly significant variation: Attacks on the enemy's military-economic potential are often given precedence over attacks on nuclear forces.¹⁶ This association of SLBMs with the destruction of the enemy's military-economic potential may suggest that the Soviets link countervalue strikes more closely with SLBMs than with ICBMs. SRBMs are used in land combat to attack the highest value military targets--especially the enemy's nuclear-capable weapons (both at bases and in the field), his military forces, and his control points.

The forecaster must decide whether the missions of ballistic missiles will change appreciably during the next two decades. Such a change could come about if either the Soviets exchange their war-fighting posture for a less ambitious assured-destruction one, or if a technological breakthrough makes ballistic missiles ineffectual. The Soviets show no signs of moving toward MAD, and the development and deployment of a truly effective anti-ballistic missile system appear unlikely. Nonetheless, the forecaster should consider these contingencies when deciding future mission priorities.

WEAPON DEFICIENCIES

Having assessed Soviet mission priorities and current capabilities, the forecaster must estimate the weapon deficiencies with which the Soviets see themselves confronted. The forecaster may find it convenient to partition deficiencies into several categories (e.g., missile lethality, control, and survivability) and to investigate these categories sequentially. *Lethality*, for example, could be investigated by dividing sets of priority targets for ICBMs, SLBMs, and SRBMs into subsets having similar vulnerabilities. Figure 2 shows a "first cut" for Grechko's list of targets. The forecaster should identify the technologies needed to threaten each target set convincingly.

Since the element of surprise is especially important for attacks on some of the target sets, the forecaster should use a partitioning process in order to discern deficiencies in Soviet *control* systems. The catchall phrase "control systems" covers the technology needed for achieving and maintaining (a) high levels of alert, (b) rapid (re)targeting, (c) precise launch times for strikes, (d) secure communication links, and (e) reconstitutable command and control, etc. A war-fighting capability depends upon its supporting systems to perform such important functions as: (a) detection, localization, and handover of targets, (b) allocation, transportation, and replenishment of weapons, and (c) battle management (including scheduling of attacks and protection of friendly forces).

Finally, the forecaster should follow a similar partitioning procedure to highlight deficiencies in the *survivability* of Soviet ballistic

Means of attack	ICBMs	Fixed based	
		Mobile based	Deceptive Dash
	SLBMs	In port	Off alert On alert
		Out of port	
	Aircraft	On ground	Off alert On alert
		Airborne	

Nuclear storage depots	
------------------------	--

C ³ I	Fixed targets	Hard Soft
	Airborne targets	

Troop formations, military bases, logistic system, defense industries	Exposed
	Temporary
	Permanent

Fig. 2--Major target sets for preemptive strike

missiles. His perspective must, of course, be that of a Soviet planner who, because he is apprehensive of a U.S. war-fighting force, must be concerned about the ability of his fixed silos, his hardened launch control sites, and essential storage bunkers to withstand nuclear effects ranging from blast (overpressure and dynamic pressure) and ground motion (lateral shock and vibration) to radiation effects (thermal, nuclear, and EMP). In addition, the Soviet planner must be concerned about the ability of his mobile weapons to exploit strategic and tactical warning by deploying rapidly, to remain hidden by controlling their telltale emissions, and to remain viable by achieving long MTBFs while operating under adverse field conditions.

WEAPON OPTIONS

The forecaster should prepare his estimate of Soviet weapon options from his knowledge of Soviet weapon deficiencies and advanced technologies. First, he must satisfy himself that the deficiencies are real and not artifacts of his analysis. He should suspect deficiencies that can be remedied by a slight shift in interpreting either Soviet literature or technology. He must assemble a set of credible Soviet strategic missile development options that respond to each of the Soviet needs for which a technology solution is indicated. Where alternative technology solutions are apparent, he should include them in the list of options. He should specify the benefits and risks associated with each option in sufficient detail to indicate:

- o The option's rationale (i.e., what Soviet needs it satisfies).
- o The option's operational performance objectives.
- o The option's technology advances.
- o A schedule which lists the major milestones necessary to the development program.
- o Unusual demands for resources (economic resources, materials, and test facilities).
- o Supporting systems which will be critical to the performance of the option.

At least three lines of reasoning justify specifying each option to this level of detail: First, an option is not really understood until these questions have been addressed. Second, a balanced 20-year forecast cannot be synthesized and defended without access to all this information. Finally, any user of the forecast will inevitably want this information in order to be able to adjust the forecast to his own view of the probable evolution of U.S. strategic forces and of the international environment.

The recurring problem of lack of knowledge about levels of Soviet performance in some key technologies may limit the specificity of some options. In such cases, the standard intelligence community practice of supplying a best estimate and confidence limits should be followed.

If the technology in question is truly critical to the sense of the option, the uncertainty should be expressed in the time domain--i.e., in what year the option would become available. Otherwise, an option's initial operational capability (IOC) can be based upon best estimates, and uncertainty can be simply expressed as a range in the performance of an option.

The comparison of Soviet needs and activities should admit the possibility that new "needs" arising from new developments in U.S. strategic forces may receive higher priority than longstanding ones.

WEAPON CHOICES

Choosing from his weapon options, the forecaster assembles his prediction, the most subjective of the inquiries. He must use his knowledge of Soviet behavior, Soviet technology, and Soviet resources to forecast the Soviet weapon acquisitions likely to occur in about ten to twenty years.¹⁷ If the initial forecast does not fit within the available resources, an amended forecast should postpone inclusion of some weapon options.

Finally, the tentative forecast should be tested against the following questions: In what areas is the forecast in disagreement with conventional wisdom? Is there a clear, logical path which has led the forecaster to his conclusions? Is there a broad base of evidence to support the forecast? What level of confidence can he attach to his forecast? What is the likelihood of gross error? Can the forecaster foresee any U.S. responses to the forecast pattern of Soviet developments which could dramatically alter the forecast? And perhaps most important: What intelligence indicators can be expected to validate the forecast?

NOTES

1. For further discussion of Soviet procurement practices, see Alexander, Arthur J., *Estimates of Operational and Defense Requirements: Military Procurement*, The Rand Corporation, N-1327, December 1979.

2. Gordon, J. J. and Olaf Helmer, *Report on Long-Range Planning Staff*, The Rand Corporation, P-2982, September 1964, p. 39. For further information about Air Force planning procedures, see Simons, W. E., et al., *Long-Range Planning Procedures for the Air Force*, The Rand Corporation, P-2982, September 1964, p. 39.

3. Testimony by Dr. John J. Martin, Assistant Secretary of the Air Force for Research, Development, and Logistics, at the Hearings on Military Posture and H.R. 10929 before the Committee on Armed Services, House of Representatives, 95th Congress, 2d Session, Part 3, Book 2, p. 65.

4. See R. Shishko, *Long-Range Military Competition: Past, Present and Future*, The Rand Corporation, P-6379, September 1979, for an excellent summary of research on military competition. See also Loftus, J. E., and A. W. Marshall, *Forecasting Soviet Power Operations: The Importance of Economic and Military Considerations*, The Rand Corporation, RM-3612, July 1963; and Wolfe, Thomas W., *Soviet Response to U.S. Military Initiatives and Programs*, The Rand Corporation, RM-4798-PR, December 1965.

5. The investigator who is comfortable with this deliberate approach to forecasting can readily find solid support and encouragement in Soviet military writing: While he was serving as Minister of Defense, Marshall Grechko wrote, "... a unified military-technical policy must ensure the priority development of those trends in scientific and technological progress in the military field which hold the best promise of meeting the growing requirements of the Soviet Union's defence more fully and comprehensively. . . . this policy orients scientists and R&D personnel towards concentrating their efforts on the more worthwhile problems and projects whose realization will have a long term effect." Continuing, he advocates: the development and exploitation of new research techniques; the development of weapons with excellent performance, especially a high destructive capacity at a minimum of expenditure; the search for rational ways for modernizing weapons; the minimization of manual labor required to operate and maintain new weapons; development of new techniques of troop and fire control; and, finally, perfection of control procedures and equipment and communications systems. See Grechko, A. A., *The Armed Forces of the Soviet Union*, Moscow Progress Publishers, 1977, pp. 157-158.

Leon Gouré and Michael J. Dean in "The Soviet Strategic View," *Strategic Review*, Vol. III, No. 4, Fall 1979, pp. 88-96, present excerpts from an article by Major-General of Engineering-Technical Services I. Anureyev: "Determining the Correlation of Forces in Terms of Nuclear Weapons," *Voennoye Mysl'*, No. 6, June 1967 (translated in *Foreign Power*

Report, No. 0112/68, July 11, 1968, pp. 35-45) and an excerpt from a response by Colonel L. Semeyko which was published in *Foreign Affairs*, No. 8, August 1968 (translated in *Foreign Affairs*, No. 0019/70, March 30, 1970). General Anureyev proposes a quantitative method to calculate a net assessment of opposing military forces before and during combat. He suggests that "the quantity of combat means, . . . destructive qualities of weapons, . . . countermeasures, . . . [and] all types of support . . ." be included in the calculations. Colonel Semeyko is skeptical about the feasibility of collecting and updating in real time all the information General Anureyev desires. These Soviet theoreticians, like their U.S. counterparts, are working at a level of detail which can develop rather definite priorities for long-term development programs.

The investigator who is uncomfortable with this deliberate approach may prefer Herbert Goldhamer's perspective in *The Soviet Union In A Period of Strategic Parity*, The Rand Corporation, R-889-PR, November 1971.

A good deal of the Soviet behavior is best understood not so much as the pursuit of a variety of quite particular military and political objectives, but as an attempt to increase her future options, to reduce those of the West, and to provide positions of strength from which she can deal with unanticipated contingencies and pursue objectives which she has not yet formulated.

In this case, the investigator may wish to concentrate his major efforts on Soviet R&D practices and to touch more lightly upon the other inquiries.

Actually, the forecast excludes from its purview much R&D activity, such as cruise missile and penetrating bomber development, which may interest (distract?) those who describe the Soviets as opportunistic. As a result, the answers reached by the "opportunists" may resemble the the answers reached by those who view the Soviets as doctrinaire.

6. The premature establishment of performance (or cost or schedule) estimates may, in fact, be counterproductive. Lieutenant General T. P. Stafford in an interview in *Armed Forces Journal*, November 1979, pp. 28-41, makes the point that "the Gemini technical specification was shorter than the Wright Brothers' and it worked slick as a whistle. We did the whole program ahead of schedule--really, I think below cost--and all the mission objectives were achieved. The whole damn thing was one page--'it will carry two men, it will have precise re-entry, do rendezvous'--and all that, and we got a solid contractor. We had solid management in NASA, and we did it." The Soviet ballistic missile procurement environment may resemble the NASA of the 1960s more than the United States of 1980 where offices in the three separate branches of government each challenge DoD technical decisions. In the same *AFJ* interview, it is noted that "the Navy just finished its first competition under the new A-109 circular for an intermediate water depth torpedo and one of the contractor's proposals, Goodyear's, was 106 feet tall." It is very difficult to distinguish when the U.S. appetite for quantitative analysis is motivated more by real need than by style and exogenous considerations. The Soviet procurement system may share our needs without adopting our style.

7. These themes are amplified by Lambeth, Benjamin S., in *How To Think About Soviet Military Doctrine*, The Rand Corporation, P-5939, February 1978, and *The Elements of Soviet Strategic Policy*, The Rand Corporation, P-6389, September 1979.

8. Articles by General Gallois and by Admiral of the Fleet Lord Hill-Norton offer insight into the strategic thinking of their two nations. See Gallois, Gen. Pierre M., "Western Europe: An Improper System of Defence," *RUSI, Journal of the Royal United Services Institute for Defense Studies*, September 1979, pp. 12-17 and Hill-Norton, Admiral of the Fleet Lord Peter, "Britain: Defence After Polaris," *The Economist*, September 15, 1979, pp. 21-28.

9. Sokolovskiy, V. D., *Soviet Military Strategy*, 3d ed., edited by Harriet Fast Scott, MacDonald Jane's, London, 1975, pp. 62-63.

10. The United States and the Soviet Union both signed the Geneva Protocol For the Prohibition of the Use in War of Asphyxiating, Poisonous, or Other Gases, and of Bacteriological Methods of War, 17 June 1925. However, both the United States and the USSR have reserved the right to retaliate in kind against any other nation which does use such weapons. The Soviets may see an advantage in stocking such weapons, anticipating that they would have the considerable advantages of first use. The differences of opinion among NATO allies about the prudence of even retaliatory use of chemical agents could inhibit any NATO response--especially if the combat action were to take place on NATO soil.

11. This last approach may prove very rewarding. For example, the doctrinal work, *Scientific-Technical Progress and the Revolution in Military Affairs*, edited by Col. Gen. N. A. Lomov, translated and published under the auspices of the USAF, has on p. 82 this revealing passage:

Abroad the opinion prevails that tactical missiles for a long time to come will remain the basic means of destruction of land forces. It is felt that their development can occur by reducing the weight and dimensions, by raising mobility, increasing the power of the charge, the range, and accuracy, by improving the fuel, and bettering the guidance system. A reduction in the weight and dimensions of the missiles can be achieved by using light, strong, fire- and corrosion-resistant metals (titanium, magnesium, aluminum alloys, and steel), graphite, glass fiber materials, plastics, and so forth. An increase in mobility can be achieved by improving the transporting vehicles on the ground, by making use of aviation and helicopters for moving the missiles, as well as preparing them for parachute dropping. Of major significance will be the conversion to rocket engines which do not require a long time for prelaunch preparation. The attention of foreign specialists has been focused on creating optimum formulas for solid missile propellants, mixed plastic fuels, and so forth. The development of gyroscopes which possess high accuracy and dependability as well as the development of various warhead homing systems will help to simplify the guidance system and to raise the missile's dependability. [italics added]

For at least 15 years, the Soviet scientific writers have been addressing systematically and rigorously fundamental problems in the theory of externally aided inertial systems. Systems described theoretically in the open Soviet literature include radio altimeter measurement of missile altitude, doppler velocity measurement, and position measurement using radar or radio navigation. Also, there are references to correction of gyroscopic axes by stellar sightings or by earth satellite reference sightings. See V. D. Adreyev, *Theory of Inertial Navigation Aids Systems*, translated from Russian for the National Aeronautics and Space Administration, Washington, D.C. by the Israel Program for Scientific Translations, Jerusalem, 1969.

In a lecture reported by *Aviation Week*, January 21, 1980, Vol. 112, No. 3, pp. 95-99, D. K. Barton evaluated a Soviet engineering textbook on electronic warfare: [Barton] "is not aware of any book in the English language that provides such basic and comprehensive coverage of ECM and ECCM principles as does the Soviet book."

12. Sokolovskiy, op. cit., p. 194.

13. Although the Soviets claim to be proponents of "the evil of good is better" school of aeronautic designs, their centralized management philosophy with apparent lack of design bureau competition may make them easy victims of needlessly expensive design approaches.

14. This approach is apparent in the No. 19, May 1979 issue of the Soviet weekly of world affairs, *The New Times*. The article, "USA: 'Counterforce' Strategy," pp. 24-25, includes this passage:

The Pentagon now insists that the U.S. strategic forces should be prepared to deal not only "selective" nuclear strikes at individual Soviet military objects but also to destroy a great number of targets, above all intercontinental ballistic missiles. The emphasis is thus on surprise (and not retaliatory) attack to undermine the Soviet strategic strength and "minimize" U.S. losses in the event of a nuclear war.

A recent comment by Gennadi Gerasino, a political correspondent for the Novosti Press Agency, on the President's Directive No. 59 reiterates this viewpoint:

The intensification of the American nuclear potential, as envisaged by this strategy, together with measures to reinforce the defense of leadership centers, looks to the other side very provocative--as a return to dreams of a preventive or pre-emptive strike which would knock the nuclear sword of retribution from the hands of the Soviet Union. (*Washington Star*, August 27, 1980, p. A9.)

In "American Nuclear Strategy: A Selective and Analytic Survey of Threat Concepts," N-1238-AF, September 1979, Michael Kanzelberger surveys some of the many contributions to nuclear strategy which have appeared in the American public literature.

15. A. A. Grechko, *Guarding Peace and the Building of Communism*, Voenizdat, Moscow, 1971, p. 41.

16. Admiral Sergei K. Gorshkov, Commander-in-Chief of the Soviet Navy since June 1956, has written extensively about the development of the Soviet Navy. In 1974 the United States Naval Institute (USNI) published *Red Star Rising at Sea*. This book includes a series of eleven articles by Gorshkov which were originally published in the official journal of the Soviet Navy, *Morskoi Sbornik*, in 1972 and 1973. In 1979, USNI published Gorshkov's book, *The Sea Power of the State*. These two books provide an authoritative, yet very readable, introduction to the Soviet Navy. On page 253 in *The Sea Power of the State*, Gorshkov explains the rationale for his submarine fleet:

Today a leading place is given in navies to those forces capable of solving important strategic tasks, pursuing the goal of undermining the military-economic potential of an enemy and shattering his nuclear sea power. Scientific analysis of the experience of past wars, the presumed character of a future war, and the trend in the development of the fleets of the imperialist states suggest that such forces are atomic-powered submarines armed with ballistic and guided missiles and naval missile-carrying and anti-submarine aviation. They have enormous strike power, possess high mobility, can conceal operations and have the ability to deliver strikes on important military-industrial and administrative centres of the enemy located on the coast and deep inland and on nuclear missile groupings of the enemy in the ocean.

17. Robert Perry, "The Interaction of Technology and Doctrine in the USAF," The Rand Corporation, P-6281, January 1979, cites four hazards to "even the most determined, brilliantly managed, well-funded effort to develop and apply technology to military ends . . . :

- o Technology can be stubbornly intractable . . .
- o The incorporation of marvelous improvements at frequent intervals [has not] guaranteed the continuing usefulness of some fundamental system that has outlived its time . . .
- o The most attractive experimental development, however soundly based and well proven, can [not] find operational employment if a matching requirement does not appear . . .
- o A capability developed skillfully and effectively against great odds and at enormous expense, can be wholly negated by the appearance of a superior (or cheaper) means of performing a function . . ."

The investigator and his audience should keep these hazards in mind, lest they take their forecast too seriously.

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